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INFLUENCE OF DIFFERENT METHODS AND TIME OF PHOSPHORUS FERTILIZER APPLICATION IN WHEAT UNDER ARID CONDITION

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A field experiment was conducted to study the effect of different time and methods of application of phosphatic fertilizer to wheat crop under Arid condition. Experiment was comprised of five treatments viz: T_1= Control, T_2= P_2O_5 broadcast at the time of seedbed preparation in the form of (TSP), T_3 = P_2O_5 side drilling after sowing, 5 cm apart rows and 5 cm deep with Rabi hand drill, T_4= P_2O_5 broadcast after sowing at the time of first irrigation and T_5= P_2O_5 mixed with seed of wheat. Results showed that although all the treatments tested were differing significantly from the control in all aspects studied but, application of phospahtic fertilizer (P_2O_5) side drilling after sowing, 5 cm apart rows and 5 cm deep with Rabi hand drill, produced maximum germination percentage (82.15), plant height (108.50 cm), number of fertile tillers m^{-2} (356), number of grains $spike^{-1}$ (41.50), 1000 grains weight (42.40 g) and grain yield (5.08 t ha^{-1}) as compared to other treatments. Maximum P contents in the straw, grain, total P uptake and protein contents in grain were recorded in T_5 was statistically at par with the T4 and T3. On the basis of these results, it can be concluded that application of phosphatic fertilizer at 5 cm apart side dressing of the rows at a depth of 5 cm not only increase the plant vigor but also produced better yield under arid condition.

Keywords: Phosphatic fertilizer, time and methods, wheat and yield

INTRODUCTION

The use of chemical fertilizer cannot be overlooked for getting maximum wheat yield. Normally the fertilizer is applied to wheat at planting time but most of the farmers usually apply less or no fertilizer. They are reluctant to apply costly fertilizer due to uncertainty of its effect on yield at early stages of its application to the crop. A question is frequently asked whether fertilizer could be applied to wheat crop at later stages. The output of fertilizer is very less than actual potential due to inappropriate application practices. It is observed that applied fertilizer may be lost due to run-off and leaching which could be utilized properly through proper method of application. There are many factors responsible for low yield of wheat but poor crop nutrition and use of varieties with low yield potential are the most important. Crop nutrition is directed by the use of N, P and K which are applied through fertilizer addition to the soil. Phosphorus counter balance the effect of excess nitrogen by hastening plant maturity, retarding excessive vegetative growth and improving grain quality. It is also involved in many biochemical processes such as cell division, photophosphorylation and protein

synthesis. The combined application of N, P and K has proved to be more effective in increasing yield of wheat as compared to sole application of either N or P or K (Ashraf, 1987). The alkaline and calcareous soils of Pakistan are low both in nitrogen (N) and in phosphorus (P), requiring the addition of nutrients in appropriate amounts for improving crop yields. Consequently, the use of N and P fertilizers increased many fold since their introduction in the late fifties (Ahmad *et al.,* 1992). Nitrogen demand increased consistently and outstripped that of phosphate, thus leading to a serious imbalance in the use of these two nutrients. It is very well known that balanced fertilization helps efficient utilization of other agricultural inputs and increases crop yields (Rashid, 1994; Alam *et al.*, 2000). Among other agronomic practices that influence the efficiency of applied fertilizer, time and method of application are also critically important. As fertilizer is a costly input and the fertilizer use efficiency under local soil and climatic conditions are low, maximum use efficiency should be the target for high economic returns. The recommended method of fertilizer application in Pakistan is to broadcast fertilizer on the surface of the soil, followed by incorporation, before seeding of the crops (Malik *et al.*, 1992). This practice enhances the conversion of soluble phosphate to insoluble forms. Water-soluble P fertilizers in the form of triple super phosphate (TSP), di-ammonium phosphate (DAP) and mono-ammonium phosphate (MAP) when applied they react with soil components to form reaction products of low water solubility (Whitelaw, 1999). The nature of the reaction products varies according to the soil pH; in acid soils, complex iron and aluminum phosphates predominates, while in calcareous soils such as those in Pakistan, di, tri, and octa-calcium phosphates are formed. In each case, the solubility of the reaction products is significantly lower than that of the applied water-soluble phosphate fertilizer. In an earlier study, Khan and Makhdum (1988) pointed out that a single application of NP to wheat could be made at sowing, but that better results were obtained if half of the N and all of the P were applied at sowing and another half of N was top dressed at first irrigation. Ahmad *et al.* (1992) while reviewing the effect of method and time of P application concluded that under irrigated conditions, phosphatic fertilizer should be top-dressed at time of first irrigation rather than its incorporation in the soil at seeding. The results of some studies, however, suggest that split application of N and P by top-dressing or by fertigation methods could produce equivalent, or in some cases, higher grain yield and P-uptake compared to incorporation of P at sowing (Latif *et al.*, 2001).

Normally phosphatic fertilizer is recommended to apply at sowing time. But due to unavailability of fertilizer to farmers at sowing time, phosphatic fertilizer is applied at the time of first irrigation.

There is a lot of contradiction in recommendation of phosphatic fertilizer application methods to wheat crop especially under "Arid" conditions. The present study was aimed at determining the influence of different methods and time of phosphatic fertilizer application to wheat under "Arid" conditions.

MATERIALS AND METHODS

The research study was conducted at Adaptive Research Farm, Karor Distt. Layyah, during rabi season 2008-09. The experiment was laid out in a randomized complete block design. The experiment consisted of four replications and a net plot size of 2.0 m x 5.0 m. Fareed- 2006, a promising variety of wheat was used as a test crop. Sowing was done on 20th November 2008 with hand drill. Seed rate was used @ 120 kg ha^{-1}. Nitrogen was applied @ 100 kg ha^{-1}. All other

cultural practices were kept normal and uniform for each treatment.

The following treatments were studied.

T_1= Control

T_2= P_2O_5 broadcast at the time of seedbed preparation in the form of (TSP)

T_3= P_2O_5 side drilling after sowing, 5 cm apart rows and 5 cm deep with Rabi hand drill

T_4= P_2O_5 broadcast after sowing at the time of first irrigation

T_5= P_2O_5 mixed with seed of wheat

Nitrogen was applied in three splits, 1/3rd of the nitrogen at sowing and remaining 2/3 rd in two equal splits each at first irrigation and at tillering stage. The source of nitrogen was urea (46% N). Row spacing of 15cm was maintained for all the treatments. Tripple Super Phosphate (TSP) as per treatment was used as a source of phosphorous @ 100 kg ha^{-1}. All other agronomic practices were kept normal and uniform for all the treatments. The crop was harvested on April 20, 2009. Agronomic data on germination count (m^{-2}), No. of tillers (m^{-2}), plant height (cm), number of grains spike^{-1}, 1000- grains weight (g), grain yield (kg ha^{-1}) was recorded by the standard procedures.

RESULTS

Germination percentage indicates the ability of seeds for seedling establishment and ultimately plants stands in the field. Greater the germination percentage of seeds, greater will be the plant population in field. The data regarding germination percentage as affected by different methods of phosphatic fertilizer application are presented in Table 1. It is clear from the data that no significant difference was observed in germination percentage of all the treatments. The data regarding plant height as affected by different methods of phosphatic fertilizer application are presented in Table 1. It is clear from the data that plant height of T2, T3 and T5 were statistically at par with each other and it was followed by the plant height in treatment where P_2O_5 was broadcasted after sowing of the crop. Minimum plant height was observed in control. It showed that phosphatic fertilizer application increases plant height of crop and ultimately biological yield of the crop. Results related to number of fertile tillers m^{-2} are given in Table 1. Maximum number of tillers was observed in treatment where phosphatic fertilizer was mixed with the seed and this was statistically at par with the treatment in which phosphatic fertilizer was broadcasted after sowing. This was followed by the treatments where phosphatic fertilizer was broadcasted at the time of seedbed preparation and where the fertilizer was given by side drill method. Minimum number of tillers was observed in control. Results showed that maximum number of grains spike^{-1} was observed in treatment where phosphatic fertilizer was applied by side drilling at 5 cm depth and at a distance of 5 cm from the rows. This was followed by the number of grains spike^{-1} where phosphatic fertilizer was broadcasted at the time of seed bed preparation. Minimum number of grains spike^{-1} was observed in the treatment where phosphatic fertilizer was mixed with the seed. Data regarding 1000 grain weight of wheat is given in Table 1. It is clear from the data that maximum grain weight was recorded in treatment where P_2O_5 was applied by side drilling method at a distance of 5 cm from the crop rows and this was statistically at par with the grain weight where P_2O_5 was applied by broadcast method after crop sowing. Minimum grain weight was noted in treatment where P_2O_5 was broadcast at the time of seed bed preparation and this was statistically at par with treatment where no P_2O_5 was applied. Results and statistical analysis of data related to grain yield are given in Table 1. It is clear from the data that there was a significant increase in the yield of all the treatments over control. The yield obtained from all the treatments other than control was statistically at par however side dressing of P_2O_5 gave maximum grain yield.

Table 1: Effect of different methods of phosphorus fertilizer application on yield and yield components of wheat crop.

Treatments	Germination (%)	Plant height (cm)	Fertile tillers (m^2)	Grains per spike	1000 grain weight (g)	Grain yield (t ha^{-1})
T1	80.45	95.50 c	306 c	26.70 c	36.10 b	3.53 b
T2	81.23	110.25 a	346 b	32.10 b	35.35 b	4.61 a
T3	82.15	108.50 a	356 b	41.50 a	42.40 a	5.08 a
T4	79.58	101.50 b	398 a	32.40 b	41.40 a	4.66 a
T5	80.69	107.00 a	433 a	33.20 d	34.12 b	5.03 a
LSD ≤ 0.05	**NS**	**4.05**	**36.00**	**1.89**	**2.34**	**0.73**

T_1= Control**,** T_2= P_2O_5 broadcast at the time of seedbed preparation in the form of (TSP), T_3= P_2O_5 side drilling after sowing, 5 cm apart rows and 5 cm deep with Rabi hand drill, T_4= P_2O_5 broadcast after sowing at the time of first irrigation and T_5= P_2O_5 mixed with seed of wheat

Data regarding the P contents in the straw, grain and total P uptake in the by the crop are presented in Table 2. Maximum P contents in the straw, grain and total P uptake were recorded in T_5 where P_2O_5 mixed with seed of wheat that was statistically at par with the T4 and T3. In case of protein, significantly higher grain protein contents were recorded in T_5 where P_2O_5 mixed with seed of wheat that was statistically at par with the T_4, T_3 and T_2.

Table 2: Effect of different methods of phosphorus fertilizer application on Phosphosus and protein contents of wheat crop

Treatments	P Content in grain (%)	P Content in straw (%)	Total P uptake (kg ha^{-1})	Protein contents (%)
T1	0.271 b	0.132 c	7.82 b	8.49 b
T2	0.298 b	0.230 b	12.60 a	10.57 a
T3	0.493 ab	0.290 ab	13.51 a	10.37 a
T4	0.423 ab	0.282 ab	13.92 a	9.99 a
T5	0.542 a	0.328 a	12.89 a	11.10 a
LSD ≤ 0.05	**0.193**	**0.091**	**1.955**	**1.403**

T_1= Control**,** T_2= P_2O_5 broadcast at the time of seedbed preparation in the form of (TSP), T_3= P_2O_5 side drilling after sowing, 5 cm apart rows and 5 cm deep with Rabi hand drill, T_4= P_2O_5 broadcast after sowing at the time of first irrigation and T_5= P_2O_5 mixed with seed of wheat.

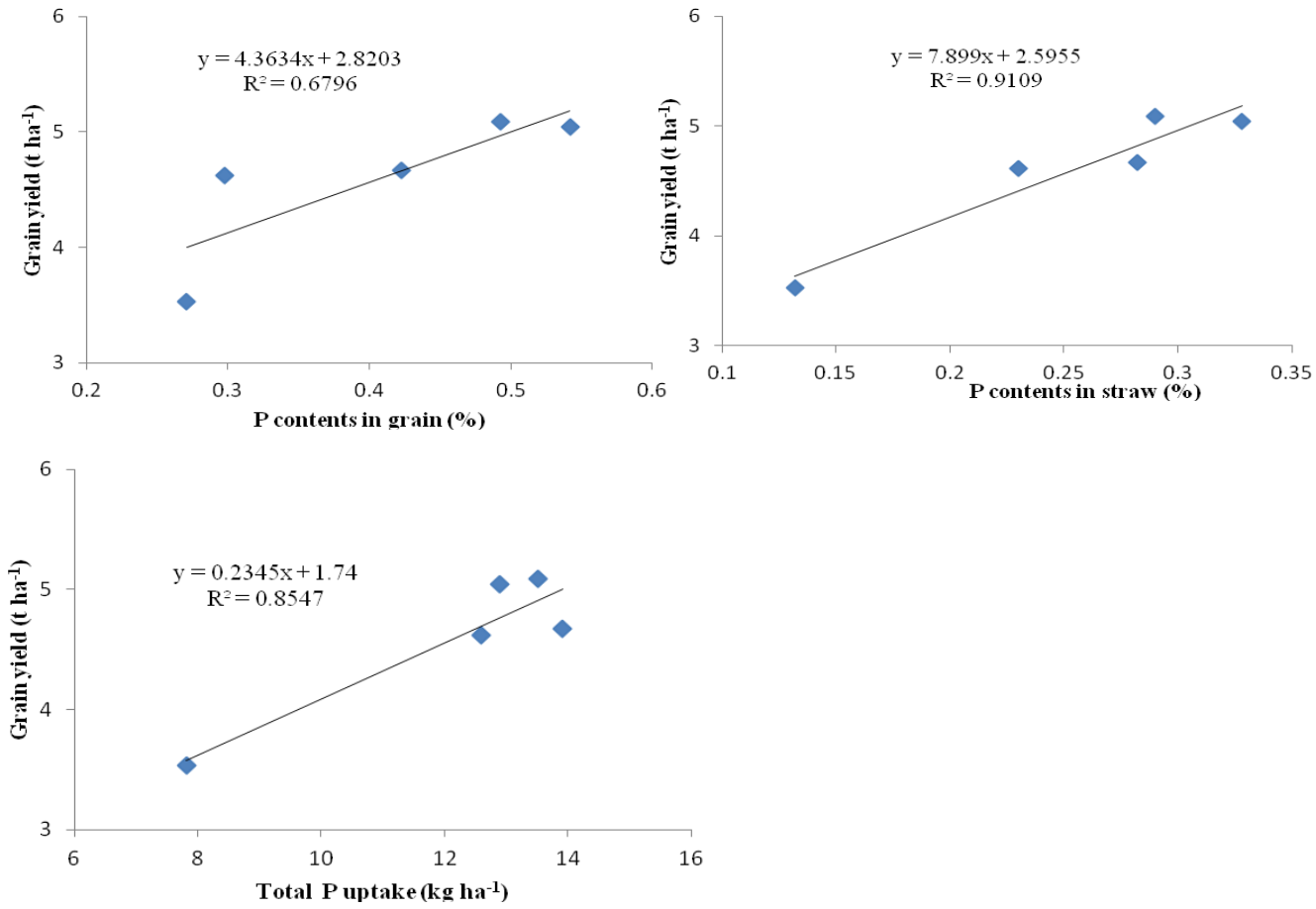

Figure 1: Correlation between the grain yield of wheat with P of grain, straw and total P uptake.

DISCUSSION

Phosphorus (P) has been identified as the most deficient essential nutrient after nitrogen (N). Nutrient inputs into production systems have increased as a result of the need for high yielding crops to sustain the growing population around the world. Efficient use of P fertilizers is important from both an economic viewpoint and the conservation of the world's phosphate resources. There are several methods of P placement. Broadcasting is the most common method of aplication on wheat fields. However, in soils with high phosphate fixation and low levels of available P, the applications of P in bands generally increases productivity relative to broadcasting (Amin *et al*., 2004). In the current study, P mixed with seed of wheat produced significantly higher fertile tillers and plant height (Table 1). These results in line with finding of Maqbool et al. (2012) who reported that mixed P with seed at the time of planting produced higher number of fertile tillers and taller plants because the P mixed with seed has a advantage of placing the fertilizer in immediate contact with the emerging radicle and seminal roots during seedling establishment. It has been also reported that phosphate fertilizer with wheat seed gives early availability of P, and in many cases total dry matter and grain production increased, even in soils with medium to high levels of available P (Alessi and Power, 1980). McConnel *et al*. (1986) cited that with medium to high soil P, this method of application was more effective. The advantage

of placement varies with soil type, application rate (Matar and Brown, 1989; Kelley *et al*., 1977), pH and soil texture (Fiedler *et al.*, 1989) and the amount of precipitation in the growing season (McConnel *et al*., 1986). Some contradictory result was found in low P soil, where P was applied in row placement gave better result than that of mixed with seed and broadcasting (Peterson *et al*., 1981). In another study it was reported that high doses of P fertilizer mixed with seed have a negative effect on germination (Mahler *et al*., 1989). This negative effect is higher in light textured soils and in conditions where there is limited moisture.

Present studies indicate that the increase in grain yield of wheat can be attributed to the increase in number of grains per spike and weight of 1000-grains. Several researchers also supported this fact. Phosphatic fertilizer applied with side drilling after sowing, 5 cm apart rows and 5 cm deep and mixed with seed during the sowing of crop significantly enhanced the number of grains per spike and weight of 1000-grains that ultimately increased the grain yield of crop. Results of current study in line with the findings of Latif *et al*. (1994) who also narrated that solution of phosphate fertilizer applied along with the first irrigation produced wheat grain yield equivalent to P mixing with seed during sowing or top dressing after plant emergence during the first irrigation. They further observed that P-uptake by wheat was also higher when phosphorus was applied by fertigation as compared to soil mixing (Latif *et al*., 1997). In addition to these, Latif *et al*. (20 03) also reported that the P applied with side dressing enhanced fresh and dry matter yield of onion over the broadcast phosphorus. Significantly the highest mung bean yield, P-up take, P- recover y and agronomic efficiency were recorded with first irrigation and the lowest with broadcast method (Shah *et al*., 2006) . The common and recommended practice of phosphorus application is to broad cast and mix in the soil before sowing. Earlier studies showed little utility of applied phosphorus before sowing until first irrigation to wheat crop (Latif et al., 19 94). Application of any phosphatic fertilizer with wheat seed enhanced seed germination, early growth, root development and also enhanced responses to mineral nitrogen fertilizer application (Rahmatullah *et al*., 1994; Gill *et al*., 1994; Pareek, 2004). It is obvious that the maximum P uptake was recorded where phosphorus fertilizers were applied with side drilling after sowing, 5 cm apart rows and 5 cm deep with Rabi hand drill that was equivalent to P applied broadcast after sowing at the time of first irrigation or mixed with seed of wheat.

It can be concluded that application of phosphatic fertilizer at 5 cm apart side dressing of the rows at a depth of 5 cm not only increase the plant vigor but also produced better yield under arid condition.

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